

We claim:

1. A magnetically shielded assembly comprised of a medical device implanted in a biological organism, wherein said medical device is disposed near biological tissue, wherein said magnetically shielded assembly is comprised of a magnetic shield disposed on at least a portion of said medical device, wherein said magnetic shield is comprised of a layer comprised of nanomagnetic material, and wherein:

- (a) said layer comprised of nanomagnetic material has a thickness of at least about 150 nanometers and a morphological density of at least about 98 percent,
- (b) said nanomagnetic material has a saturation magnetization of from about 1 to about 36,000 Gauss, a coercive force of from about 0.01 to about 5,000 Oersteds, and a relative magnetic permeability of from about 1 to about 500,000, and an average particle size of less than about 100 nanometers.

2. The magnetically shielded assembly as recited in claim 1, wherein said layer comprised of nanomagnetic material has an average surface roughness of less than 100 nanometers.

3. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material has a saturation magnetization of from about 500 to about 10,000 Gauss.

4. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of nanomagnetic material has a thickness of less than about 2 microns.

5. The magnetically shielded assembly as recited in claim 4, wherein said nanomagnetic material has a saturation magnetization in excess of 20,000 Gauss.

6. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material is comprised of atoms selected from the group consisting of iron atoms, cobalt

atoms, nickel atoms, gadolinium atoms, samarium atoms, and mixtures thereof

7. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material has a coercive force of from about 0.01 to about 3,000 Oersteds.

8. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material has a coercive force of from about 0.1 to about 10 Oersteds.

9. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material has a relative magnetic permeability of from about 1.5 to about 260,000.

10. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material has a relative magnetic permeability of from about 1.5 to about 2,000.

11. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material is disposed within an insulating matrix.

12. The magnetically shielded assembly as recited in claim 2, wherein, when said magnetically shielded assembly is tested in accordance with A.S.T.M. Standard Test 2182-02, it has a heat shielding factor of at least 0.3.

13. The magnetically shielded assembly as recited in claim 2, wherein said assembly further comprises antithrombogenic material.

14. The magnetically shielded assembly as recited in claim 2, wherein said nanomagnetic material is comprised of iron-containing magnetic material.

15. The magnetically shielded assembly as recited in claim 14, wherein said iron-containing magnetic material is selected from the group consisting of FeAl material, FeAlN material, FeAlO material, and mixtures thereof.

16. The magnetically shielded assembly as recited in claim 2, wherein said medical

device is comprised of a conductor with a resistivity at 20 degrees Centigrade of from about 1 to about 100-microhm-centimeters.

17. The magnetically shielded assembly as recited in claim 16, wherein said conductor has a bend radius of less than 2 centimeters.

18. The magnetically shielded assembly as recited in claim 2, further comprising a layer of nanothermal material disposed above said layer comprised of nanomagnetic material.

19. The magnetically shielded substrate as recited in claim 18, wherein said layer of nanothermal material has a thickness of less than 2 microns.

20. The magnetically shielded substrate as recited in claim 19, wherein said layer of nanothermal material has a thermal conductivity of at least about 2000 watts/meter-degree Kelvin.

21. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of nanomagnetic material has a thickness of from about 750 to about 850 nanometers.

22. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a stent comprised of wire mesh.

23. The magnetically shielded assembly as recited in claim 22, wherein said layer of comprised of nanomagnetic material is contiguous with said wire mesh.

24. The magnetically shielded assembly as recited in claim 23, wherein said nanomagnetic material has an average particle size of less than about 20 microns.

25. The magnetically shielded assembly as recited in claim 24, wherein said layer comprised of nanomagnetic material is also comprised of nanodielectric material.

26. The magnetically shielded assembly as recited in claim 25, wherein said

nanodielectric material has a resistivity at 20 degrees Centigrade of from about 1×10^{-6} ohm-centimeters to about 1×10^{-5} ohm-centimeters.

27. The magnetically shielded assembly as recited in claim 26, wherein nanomagnetic material is homogeneously dispersed within said nondielectric material.

28. The magnetically shielded assembly as recited in claim 27, wherein said layer comprised of nanomagnetic material is comprised of at least about 70 mole percent of nanodielectric material, by total number of moles of nanodielectric material and nanomagnetic material present in such layer.

29. The magnetically shielded assembly as recited in claim 2, wherein said medical device has a cylindrical shape.

30. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a catheter assembly.

31. The magnetically shielded assembly as recited in claim 30, wherein said catheter assembly is comprised of a multiplicity of lumens.

32. The magnetically shielded assembly as recited in claim 31, wherein a sheath is disposed over said catheter assembly.

33. The magnetically shielded assembly as recited in claim 30, wherein said catheter assembly comprises an elongated tubular body having a single lumen disposed therein.

34. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a guide wire assembly.

35. The magnetically shielded assembly as recited in claim 34, wherein said guide wire assembly is comprised of a coiled guide wire.

36. The magnetically shielded assembly as recited in claim 2, wherein said medical

device is a self-expanding stent.

37. The magnetically shielded assembly as recited in claim 36, wherein said self-expanding stent is comprised of joined metal stent elements and a flexible film.

38. The magnetically shielded assembly as recited in claim 37, wherein said flexible film is coated with said layer comprised of nanomagnetic coating.

39. The magnetically shielded assembly as recited in claim 38, further comprising a sheath disposed over said flexible film.

40. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a biopsy probe assembly.

41. The magnetically shielded assembly as recited in claim 40, wherein said biopsy probe assembly is comprised of a hollow tubular cannula and a solid stylus.

42. The magnetically shielded assembly as recited in claim 41, wherein said layer comprised of nanomagnetic material is contiguous with cannula.

43. The magnetically shielded assembly as recited in claim 42, wherein a sheath is disposed over said cannula.

44. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a flexible tube endoscope assembly.

45. The magnetically shielded assembly as recited in claim 2, wherein a sheath assembly is disposed over said medical device.

46. The magnetically shielded assembly as recited in claim 45, wherein said sheath assembly is comprised of a sheath with a surface comprising a multiplicity of magnetic materials.

47. The magnetically shielded assembly as recited in claim 46, wherein said sheath has

tubular shape.

48. The magnetically shielded assembly as recited in claim 47, wherein said sheath is contiguous with said medical device.

49. The magnetically shielded assembly as recited in claim 46, wherein said sheath is comprised of a tearable seam.

50. The magnetically shielded assembly as recited in claim 46, wherein said sheath is comprised of a multiplicity of liquid crystal nanomagnetic particles.

51. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of a multiple strand conductor.

52. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of a multifilar coiled conductor.

53. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of a monofilar conductor.

54. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of an electrode.

55. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of a lead body that carries at its distal end an insulative electrode head.

56. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of a torque transfer stylet.

57. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of nanomagnetic material has a tensile modulus of elasticity of at least about 15×10^6 pounds per square inch.

58. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a steerable guide wire.

59. The magnetically shielded assembly as recited in claim 2, wherein said medical device is a transesophageal medical lead.

60. The magnetically shielded assembly as recited in claim 2, wherein said medical device is comprised of a braided wire mesh assembly.

61. The magnetically shielded assembly as recited in claim 2, wherein said magnetically shielded assembly is further comprised of a layer of nanoelectrical material.

62. The magnetically shielded assembly as recited in claim 61, wherein said nanoelectrical material has an average particle size of less than 100 nanometers and relative dielectric constant of less than about 1.5.

63. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of said nanomagnetic material has a morphological density of at least about 99.5 percent.

64. The magnetically shielded assembly as recited in claim 63, wherein said layer comprised of nanomagnetic material has an average surface roughness of less than about 10 nanometers.

65. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of nanomagnetic material is hydrophobic.

66. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of nanomagnetic material is hydrophilic.

67. The magnetically shielded assembly as recited in claim 66, wherein said medical

device is operatively connected to an electrical circuit.

68. The magnetically shielded assembly as recited in claim 67, wherein said electrical circuit is a filter circuit.

69. The magnetically shielded assembly as recited in claim 68, wherein said filter circuit is comprised of an inductor.

70. The magnetically shielded assembly as recited in claim 69, wherein said filter circuit is comprised of a capacitor.

71. The magnetically shielded assembly as recited in claim 70, wherein said filter circuit is comprised of a resistive load.

72. The magnetically shielded assembly as recited in claim 71, wherein said resistive load is comprised of a thermoelectric cooling device.

73. The magnetically shielded assembly as recited in claim 70, wherein said filter circuit is comprised of a tank circuit.

74. The magnetically shielded assembly as recited in claim 70, wherein said medical device is a pacemaker.

75. The magnetically shielded assembly as recited in claim 70, wherein said medical device is a defibrillator.

76. The magnetically shielded assembly as recited in claim 70, wherein said filter circuit is electrically connected to a conductive patch.

77. The magnetically shielded assembly as recited in claim 2, wherein said layer comprised of nanomagnetic material is comprised of at least about 30 weight percent of said nanomagnetic material.

78. The magnetically shielded assembly as recited in claim 70, wherein said filter circuit

is a current-limiting filter circuit.

79. The magnetically shielded assembly as recited in claim 2, wherein said magnetic shield is comprised of a substrate, and wherein said substrate is comprised of a top surface and a bottom surface and a multiplicity of openings extending from said top surface to said bottom surface.

80. The magnetically shielded assembly as recited in claim 79, wherein said layer comprised of nanomagnetic material is disposed over said substrate.

81. The magnetically shielded assembly as recited in claim 80 wherein said nanomagnetic material has an average particle size of less than about 20 nanometers.

82. The magnetically shielded assembly as recited in claim 81, wherein said nanomagnetic material has a saturation magnetization of from about 10,000 to about 26,000 Gauss.

83. The magnetically shielded assembly as recited in claim 82, wherein said layer comprised of nanomagnetic material has a thickness of from about 500 to about 1,000 nanometers.

84. The magnetically shielded assembly as recited in claim 83, wherein said layer of nanomagnetic material is comprised of electrical circuitry.

85. The magnetically shielded assembly as recited in claim 84, wherein said electrical circuitry is adapted to limit current flow through biological tissue.

86. The magnetically shielded assembly as recited in claim 84, wherein said electrical circuitry is adapted to limit current flow through said medical device.

87. The magnetically shielded assembly as recited in claim 2, wherein said magnetic shield is comprised of a layer of nanoelectrical material disposed around said layer of

nanomagnetic material, wherein: said layer of nanoelectrical material has a thickness of from about 0.5 to about 2 microns and a resistivity of from about 1 to about 100 microhm-centimeters.

88. The magnetically shielded assembly as recited in claim 2, wherein said magnetic shield is comprised of a layer of nanothermal material disposed around said layer comprised of nanomagnetic material, wherein said layer of nanothermal material has a thermal conductivity of at least about 150 watts/meter-degree Kelvin and a resistivity of at least about 10^{10} microhm-centimeters.